Procedure to Assemble the Expansion chamber

to the Synthetic Quartz jar

Starting condition:
Synthetic Quartz jar from Covalent is double bagged, virgin condition from vendor. High Purity expansion volume is clean, double bagged, clean condition from Astro-Pak. Parts for assembly are cleaned (at FNAL A0 facility), double bagged. See parts list spreadsheet.

Caution: The high purity expansion chamber weighs about 100 lbs. The backing flange weighs 52 lbs. Two able bodied persons working together are required to move these heavy object to prevent personal injury. The flanges have 3/8"-16 threaded holes around the perimeter that can be used for lifting. Five inch long shoulder screws can be threaded into these holes to provide handles.

Procedure

1. Turn on (or verify) the air filters and lighting of the class 100 preparation cleanroom and the class 10 assembly cleanroom have been running for at least one hour. Filters and ventilation must continue through the procedure.
2. Follow cleanroom attire and protocols when working in the cleanroom. Special attire such as class 10 gloves, hoods, and glasses are necessary.

Picture: Parts staged in class 100 prep cleanroom.

3. Assemble all required parts, tools, and equipment in the class 100 preparation room.
4. Wipe down the rotation assembly fixture and move it into the class 10 cleanroom. Lock the brakes of assembly fixture to keep the shaft from rotating.
5. Make note of two 3/8"-16 x ½" long bolts that are in the rotation fixture. They will be used to secure the bottom flange into the fixture.

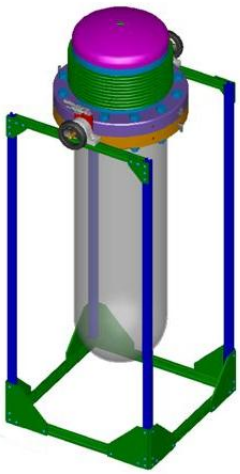


Figure: Solid model of rotation assembly fixture with BC assembly.

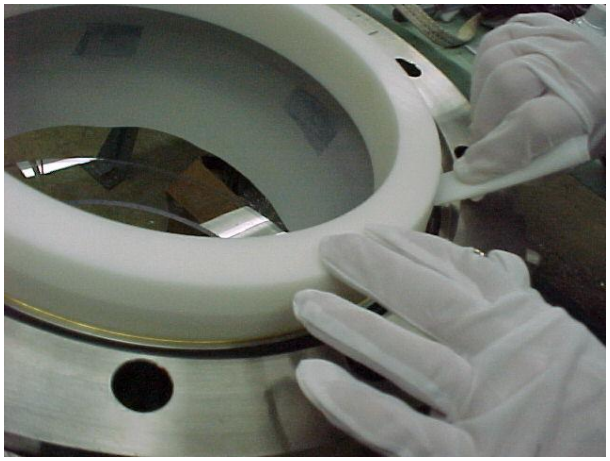
Picture: Rotation assembly fixture.

7. Remove the outer bags from the assembly parts while in the preparation area and then roll the cart of parts into the class 10 assembly area.
8. Leave the double bagged Covalent jar in its box in the prep room for now. Also leave the expansion volume chamber in the prep room for now.

Bottom Backing flange

9. Remove the final bag from the bottom backing flange. Place the bottom flange into the assembly fixture with the lip up to accept the quartz jar flange. The inter-seal pump out ports should be orientated to the front and back of the fixture. Secure it with bolts.
10. Line the inside surface of the flange with a thin Teflon sheet. Tape it to the flange from the outside only. The purpose of the Teflon sheet is to protect the quartz jar from contacting the flange when it is manually lowered through the flange.
11. Wipe down the jiffy jack and place it on the floor inside the assembly fixture.
12. Adjust the height of the jiffy jack so that the vertical distance from the sealing surface of the flange to the surface of the jiffy jack is 37". Confirm that the jiffy jack can be lowered 1.5" from this position. Leave it at the 37" position.

13. Inspect the bottom flange o-ring groove and flat surface for gold o-ring with magnifying glass. Remove foreign matter and/or clean as necessary. Class 10 quality tech wipes saturated with isopropyl alcohol and de-ionized water may be used.
14. Remove the final bag of the Viton o-ring. Inspect the o-ring for cleanliness and surface condition. Place the Viton o-ring into the o-ring groove.
15. Remove the outer bag and place the Teflon positioning tool into flange.
16. Remove the outer bag and position a 0.031" dia. x 12.15 over the Teflon positioning tool.
17. Use Teflon push rods to stretch and push down the gold o-ring onto the backing flange. See picture.



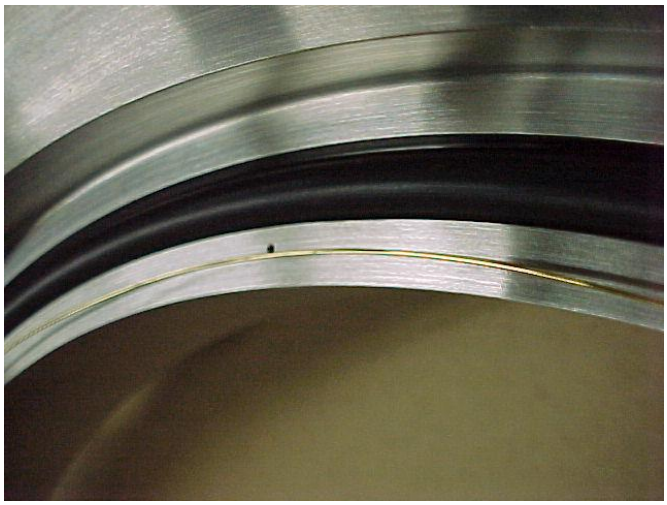
Picture: Teflon tool is used to stretch and push gold o-ring down the cone.

18. Remove the Teflon positioning tool.
19. Inspect the gold o-ring carefully and center it as necessary with tweezers or the scalpel.

Picture: Backing flange with Viton o-ring, gold o-ring, and Teflon liner.

20. The gold o-ring must be inside the small evacuation port holes. See the picture below. This is more important for the upper flange that will be done later. In the

case of the lower backing flange, aligning the gold o-ring in this way will assure proper concentric alignment of the lower gold seal with the upper gold seal. The lower gold seal and Viton o-ring serve to provide complimentary symmetric loading across the quartz jar flange. The lower gold seal and Viton o-ring are not leak checked nor required to be leak tight.



Picture: Gold o-ring centered and inside of evacuation port hole.

21. The next steps shall be performed in succession without delay. Two persons using good communication should work together to ensure the safety of the jar.
22. Prepare a clean (surface covered with clean polyethylene or plastic material) four wheel dolly. Wipe down the horizontal surface with tech wipes.

Synthetic quartz jar

23. Lift the bagged synthetic quartz jar out of the card board box and place it open mouth down onto the dolly. Wipe down the exterior of the bag as needed.

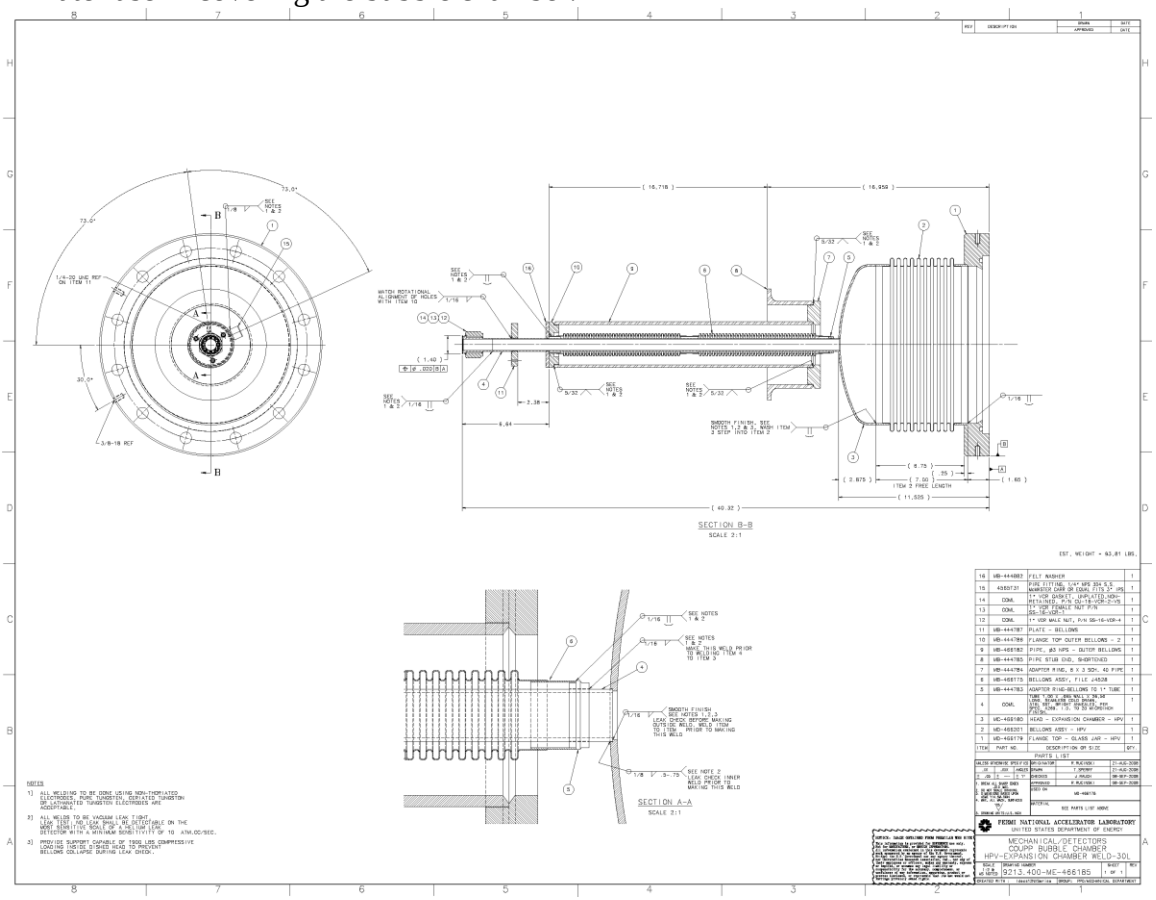
Picture: Double bagged Covalent Synthetic quartz jar in shipping box.

24. Use scissors to pierce and cut the outer bag off just above the flange. Pull or roll it up and off the jar.
25. Tilt and lift and rotate the jar to allow the outer bag that is inside of the jar to be pulled out and off. Return the jar open mouth down onto the dolly.
26. Roll the dolly and jar assembly into the class 10 assembly area.
27. Pierce and cut the innermost bag off just above the flange. Pull or roll it up and off the rounded end of the jar. Save the bag for later use in covering the bubble chamber.
28. Tilt and lift and rotate the jar and pull out the inner bag while it is in the open mouth down orientation.
29. Continue to lift and rotate so that the rounded end of the jar is down and the open mouthed end is up.
30. Lift the jar up and over the backing flange and slowly lower it until it rests on the jiffy jack. The flange of the jar should end up elevated about 0.9" above the flange.
31. Carefully inspect the flange for imperfections such as pits, half bubbles, scratches, inclusions that could interfere with sealing.
32. Clean the contact edges of the plastic caliper set.
33. Measure the thickness of the flange in several locations using plastic (so as not to scratch the jar) calipers. The thickness should be 1.000" +/-0.005".
34. Clean the contact edges of the non-metallic straight edge.
35. Check the flatness and straightness using a non-metallic straight edge across the flange at various orientations. If applicable, use feeler gages to quantify observations. Flatness should be to better than +/-0.005".
36. Inspect the cleanliness of the upper and lower surfaces of the flange.
37. Lower the jiffy jack to lower the quartz jar onto the Viton o-ring. Check that the gold o-ring is still properly positioned under the flange.
38. Temporarily cover the opening with the inner bag or other cover.

39. Loosely attach Teflon ears around the backing flange. The ears will guide the upper flange to a concentric mating.

High Purity Expansion Volume

40. Cut the outer bag off of the high purity expansion volume assembly. Tilt the assembly to remove the outer bag from the interior.
41. Roll the high purity expansion assembly into the class 10 cleanroom assembly area.
42. Pierce and cut the innermost bag off the high purity expansion volume assembly. Tilt the assembly to remove the outer bag from the interior. Save the bags for later use in covering the bubble chamber.



Drawing: FNAL drg. # 9213.400-ME-466185 High Purity Expansion Chamber.

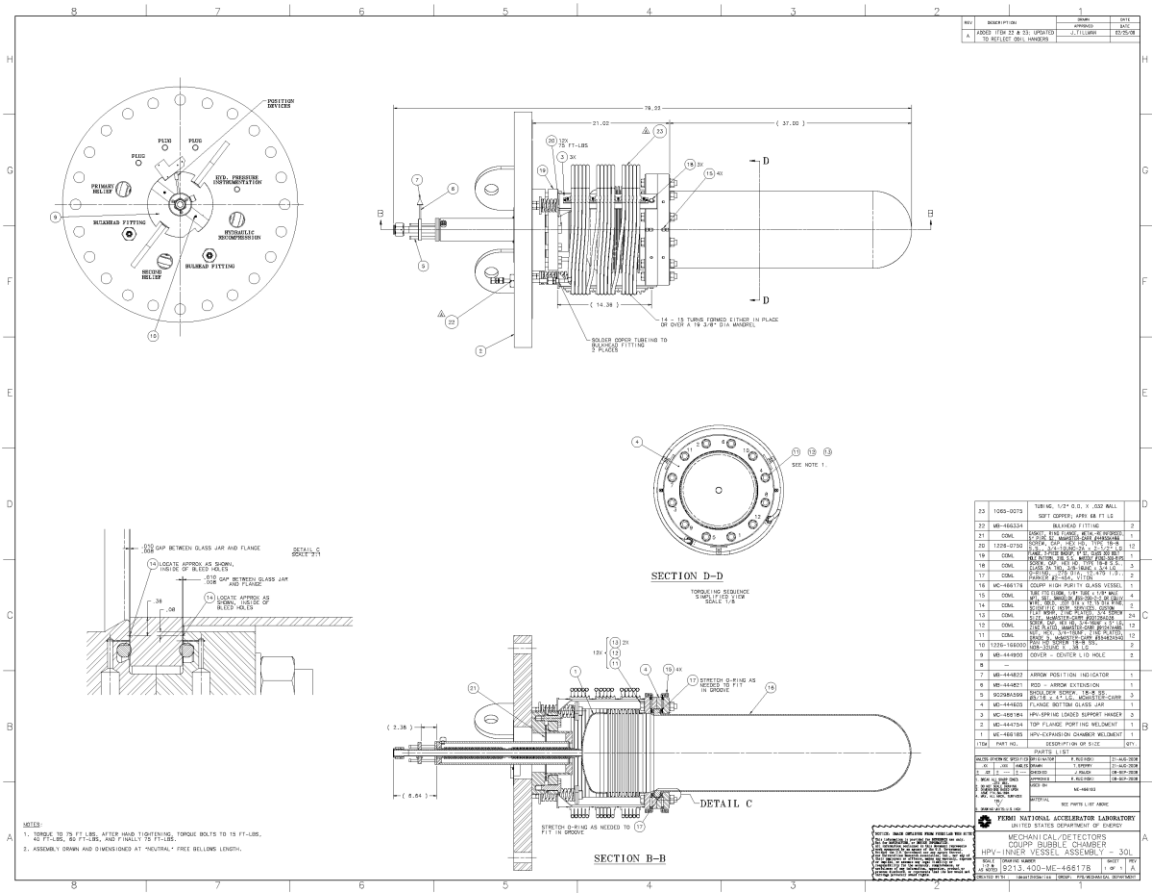
43. Visually inspect the sealing surface and o-ring groove of the upper flange. Remove foreign matter and/or clean as necessary. Class 10 quality tech wipes saturated with isopropyl alcohol and de-ionized water may be used.
44. Remove the final bag of the Viton o-ring. Inspect the o-ring for cleanliness and surface condition. Press the Viton o-ring into the dovetail o-ring groove.
45. Screw in shoulder bolts as handles to lift the expansion chamber (optional).

Picture: HP expansion volume with vacuum restraint

46. Remove the outer bag and inspect the cleanliness of the Teflon positioning tool. Place the Teflon positioning tool into the opening jar.
47. Remove the outer bag and position a 0.031" dia. x 12.15 over the Teflon positioning tool.
48. Use Teflon push rods to stretch and push down the gold o-ring onto the quartz flange.
49. Inspect the gold o-ring carefully and center it as necessary with tweezers or the scalpel.
50. Inspect the gold wire with a magnifying glass for the entire perimeter. Adjust around imperfections in the jar flange surface and or remove any fuzz or contamination.
51. Lift the high purity expansion volume assembly and gently place it on the jar and backing flange assembly. Take care to align the pump out ports towards the front and back of the fixture. Also align the bolt holes.
52. Plug both ports of the 1/8" FPT leak checking ports in the backing flange. With Teflon tape on the pipe threads, screw the Cajon 1/8" x ¼" VCO elbow into the evacuation ports of the upper flange.

Tightening Flange Bolts

53. Make note of hole designations for the tightening sequence with reference to FNAL drawing 9213.400-ME-466178. Starting with the hole just to the right of the front pump out and going clockwise around the flange the numbers will be 1, 5, 9, 3, 7, 11, 2, (back pump out) 6, 10, 4, 8, 12. This is the standard sequence for tightening a 12 bolt pattern.



Drawing: FNAL drg. # 9213.400-ME-466178 High Purity BC Inner Vessel Assembly

54. By hand, outside of the flange assembly, run each nut up the bolt to chase the threads. Then remove the nut and assemble the bolt, washers, and nut in each hole and hand tighten to a snug condition. Initially the gap may be as high as 0.080” because the jar is suspended between the Viton o-rings.
55. The threads of the bolts are 0.75”-16UNF, so each quarter turn will reduce the bolted length by 0.016” (bolt stretch is negligible). Sequentially tighten the bolts in eighth or quarter turn increments until the clearance between the two flanges is 0.043” or the torque applied is 5 ft-lbs.
56. Measure the gap between the flanges at six locations around the perimeter using the table below as an example.

Gold wire diameter at start = 0.031"
Quartz Jar Thickness = 1.000"
Each Flange edge deflects = 0.004" at 1000 lbs/inch loading
Perimeter gap at start of gold compression = 0.044"

	Perimeter Gap									
Torque (ft-lbs)	1-12 (inches)	9-5 (inches)	7-3 (inches)	2-11 (inches)	10-6 (inches)	8-4 (inches)	Perimeter Average (inches)	Expected Gap (inches)	Expected gold wire thickness (inches)	Calculated Gold Compressive Force (lb/inch)
5	*0.036*	*0.038*	*0.038*	*0.040*	*0.040*	*0.038*	*0.038*	0.0429	0.031	132
15	*0.026*	*0.024*	*0.022*	*0.022*	*0.025*	*0.026*	*0.024*	0.0245	0.023	395
40	*0.021*	*0.018*	*0.017*	*0.016*	*0.018*	*0.020*	*0.018*	0.0102	0.018	1055
60	*0.018*	*0.017*	*0.015*	*0.014*	*0.016*	*0.017*	*0.016*	0.0007	0.016	1582
75	*0.014*	*0.015*	*0.013*	*0.011*	*0.013*	*0.013*	*0.013*	0.0000	0.014	1977

Values in italics are example data from mechanical prototype

Table: Gap measurement data during torquing.

57. At this point, the viton O-rings are compressed such that the quartz flange is making contact with the 0.031" diameter gold wire o-rings. The torque required to compress the gap further will increase significantly.
58. Sequentially tighten the bolts in the prescribed criss-cross pattern to **15 ft-lbs**. Take several times around to get all bolts uniformly to the correct final torque.
59. Measure and record the gap between the upper and backing flange at six places around the perimeter. The gap should be uniform to 0.004".
60. The torque may decrease over time (fifteen minutes) as the gold yields and flows.
61. Sequentially tighten the bolts in the prescribed criss-cross pattern to **30 ft-lbs**. Take several times around to get all bolts uniformly to the correct final torque.
62. Measure and record the gap between the upper and backing flange at six places around the perimeter. The gap should be uniform to 0.004".
63. Sequentially tighten the bolts in the prescribed criss-cross pattern to **40 ft-lbs**. Take several times around to get all bolts uniformly to the correct final torque.
64. Measure and record the gap between the upper and backing flange at six places around the perimeter. The gap should be uniform to 0.004".

Carten Valve(s)

65. Connect MV-84, the 1" Carten Valve to the top of the expansion chamber. The rotational orientation should be such that the purge ports of the valve are opposite the vent port in the 3" pipe. This will reduce the possibility of interference when the purge port connections are added. Temporarily cap the open end of MV-84 to keep dust or particles from settling inside. Close MV-84.

66. Connect the short 45 degree tube spool and MV-80 to the bubble chamber side purge port.

Leak Checking

67. Connect the dry Alcatel helium mass spectrometer leak detector to MV-80.
68. Pull a vacuum in the bubble chamber and perform a helium leak check of the upper flange gold seal (blow helium into inter-seal space), VCR connections at MV-80 and MV-84, and bellows, and welds.
69. The leak rate thru the gold seal at 40 ft-lbs should be less than 10E-6 mbar-l/s. Find and repair any leaks.
70. Wait over night or longer to allow the gold o-ring to creep. Check the final torque to 40 ft-lbs and do a final leak check. A maximum leak rate of 10E-6 mbar-l/s is desired.
71. Consider whether to increase the torque on the bolts to further close the perimeter gap and possibly reduce the helium leak rate. Judgment is needed.
72. Back fill with filtered Gaseous argon (source is cryogenic liquid dewar boil-off). The Balston BX filter at the wall manifold is rated to remove 99.99% of 0.01 micron particles. The Acro50 vent filter (Pall number 4251) that will be used as a final point of use filter is 0.2 micron pore size.
73. Close MV-80 and disconnect the leak detector.

Rinsing

74. Connect the long spray wand to the Millipore Element point of use water source. This de-ionized and conditioned water is filtered to 0.22 microns.
75. Flush the long spray wand (for the quartz jar) and measure the effluent with the water conductivity meter. When the effluent conductivity measures less than 0.057 µS-cm (resistivity > 17.5 megohms) the wand can be considered clean.
76. Use the spray wand to test spray the interior of a prototype jar to verify that the spray pattern and results will be as desired.
77. Flush the short spray wand (for the bellows) and measure the effluent with the water conductivity meter. When the effluent conductivity measures less than 0.057 µS-cm (resistivity > 17.5 megohms) the wand can be considered clean.
78. Use the spray wand to test spray the interior of a prototype jar to verify that the spray pattern and results will be as desired.
79. Position a large funnel with hose leading to the floor drain under the bubble chamber approximately where the jiffy jack was previously positioned.
80. Rotate the bubble chamber assembly, uncap and open MV-84. Insert the long spray wand into the bubble chamber.
81. Rotate the bubble chamber assembly upside down. Rinse the bubble chamber interior surface down with water. Work from the closed end down the walls to the expansion chamber.
82. Remove the long spray wand from the bubble chamber.
83. Insert the short spray wand into the bubble chamber. With the bubble chamber inverted, rinse down the interior surface of the bellows.
84. Measure the effluent with the water conductivity meter. The effluent should measure less than 0.057 µS-cm (resistivity > 17.5 megohms).

85. Remove the short wand from the bubble chamber. Rotate the bubble chamber to try to remove all free water.
86. Cap MV-84 with a 1" unplated 316 stainless steel VCR gasket. Leave the valve open.
87. Connect a dry vacuum pump to MV-80. Evacuate the bubble chamber and backfill with the filtered gaseous argon. Pump and backfill to slightly positive pressure (1 psig) four times.
88. Close MV-80 and disconnect the pumping line. Attach a VCR cap to MV-80.
89. Close MV-84.
90. Cover the bubble chamber assembly with Marvel Seal bags to keep the assembly clean and dark. Store covered from light in a clean, cool, place such as the class 10 cleanroom until the additional tubing pieces, PT83 and MV-83 and filter are ready for attachment.
91. The End.